Helpful Hints:
How to Use Dichotomous Keys

The word *dichotomous* comes from the Greek words *dikha*, "in two," and *temnein*, "to cut." Thus, it's meaning: "division into two contradictory parts." A *key* is a table glossary, or cipher, for decoding or interpreting. A *dichotomous key* is a branching decoder, which forks into two approximately equal and contradictory divisions that lead to only one correct outcome. It is like a mouse maze. For the mouse to escape, it must make successive choices between two directions, one correct and one incorrect. The mouse will get out only after making all the correct choices.

To use a dichotomous key we, too, must choose correctly between two options in a series of contradictory options. We use our five senses (sight, hearing, touch, taste, and smell) to determine the correct choices. Here is a simple example of how we might choose what type of shoe we are wearing.

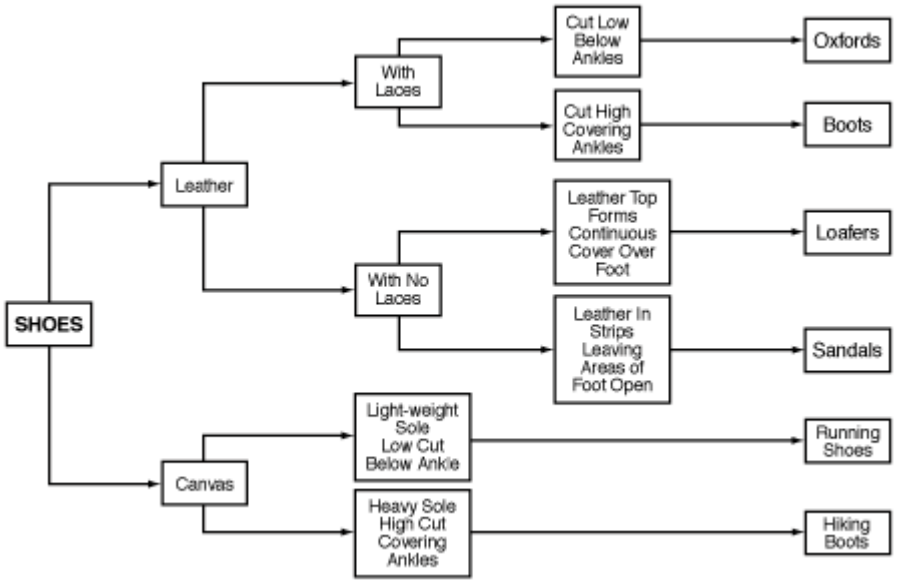
Assume you are wearing a pair of canvas running shoes. The first choice in the key asks if the shoes are made of leather or canvas. Since they are made of canvas, not leather, you follow the "path" to "CANVAS." Here you are asked if your shoes have lightweight soles and are low-cut or if they have heavy soles and are high-cut. Yours are lightweight and low-cut, so you have identified them as canvas running shoes.

Note that *all* dichotomous keys have inherent limitations. In this example, only six types of shoes are included. Even very extensive and technical keys omit some possible choices. This is especially true of exotic vegetation species that have been introduced into an area. Many dichotomous keys only include native species. If the plants you are trying to identify aren't native or your dichotomous key isn't complete enough, you may need to seek expert help.

A second limitation of many dichotomous keys is their use of imprecise terminology (e.g. "low-cut," "lightweight," etc.). Sometimes it is not clear what the authors of the key mean by these terms. The best keys are those that use objective, measurement-based characteristics rather than subjective options.

To help you identify species or find a local dichotomous key, consult foresters, local experts, university research scientists, etc. Your GLOBE Country Coordinator may also have useful information.

Figure LAND-P-12: Using a Dichotomous Key



How to Measure Tree Height and Circumference

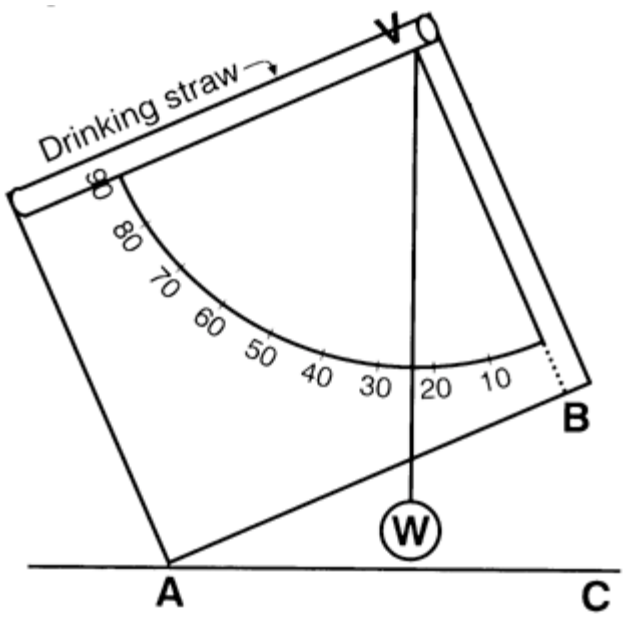
How to Choose Which Trees to Measure

1. If the dominant species on your site is a tree, select five specimens of the tree. Include the largest tree, the smallest tree that still reaches the canopy, and three intermediate trees. Mark the trees for future reference.
2. If you have a co-dominant tree species, repeat the process. If there are fewer than five co-dominant species trees, include other tree species to make a total of five. Mark the trees for future reference.

How To Measure Tree Height Using a Clinometer

A clinometer measures angles to determine the heights of objects without directly measuring them. It is a simplified version of the *quadrant* (a medieval measuring instrument), and the *sextant*, an instrument used to locate the positions of ships. Like these instruments, the clinometer has an arc with graduated degree markings that go from 0 to 90 degrees. See Figure LAND-P-13. When you site an object through the clinometer's drinking straw, you can read the number of degrees of angle BVW by noting where the string touches the arc. Angle BVW is equal to angle BAC, which is the angle of elevation of the clinometer. If you know both the angle of elevation and your distance away from an object, you can calculate the height of that object using a simple equation.

Figure LAND-P-13: Homemade Clinometer



Modified from Bennett, A. and Nelson, L. (1961) Mathematics an Activity Approach. Allyn & Bacon: Boston.

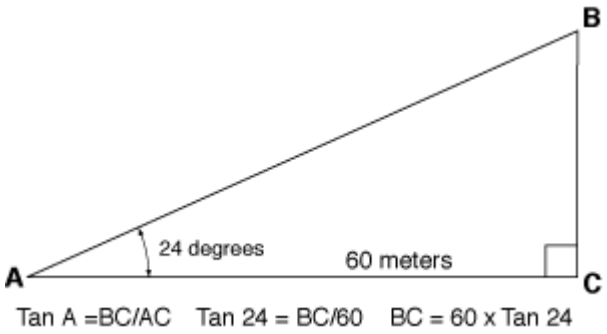
Step 1: Make a Clinometer

- Glue a copy of the Clinometer Sheet in the Appendix onto a same-size piece of stiff cardboard.
- Punch a hole through the marked circle on the sheet and tie one end of a 15 cm piece of string through it.
- Tie a metal nut or washer to the other end of the string.
- Tape a drinking straw along the designated line on the sheet, to use as a site.

Step 2: Measure and Record the Distances and Angles Needed to Determine Tree Height

- At one of your selected trees, move a predetermined distance away from the base of the tree and record the distance. This is your line AC. See Figure LAND-P-14. For the most accurate results you should adjust your distance away from the base of the tree so that Angle BVW is between 30 degrees and 60 degrees.

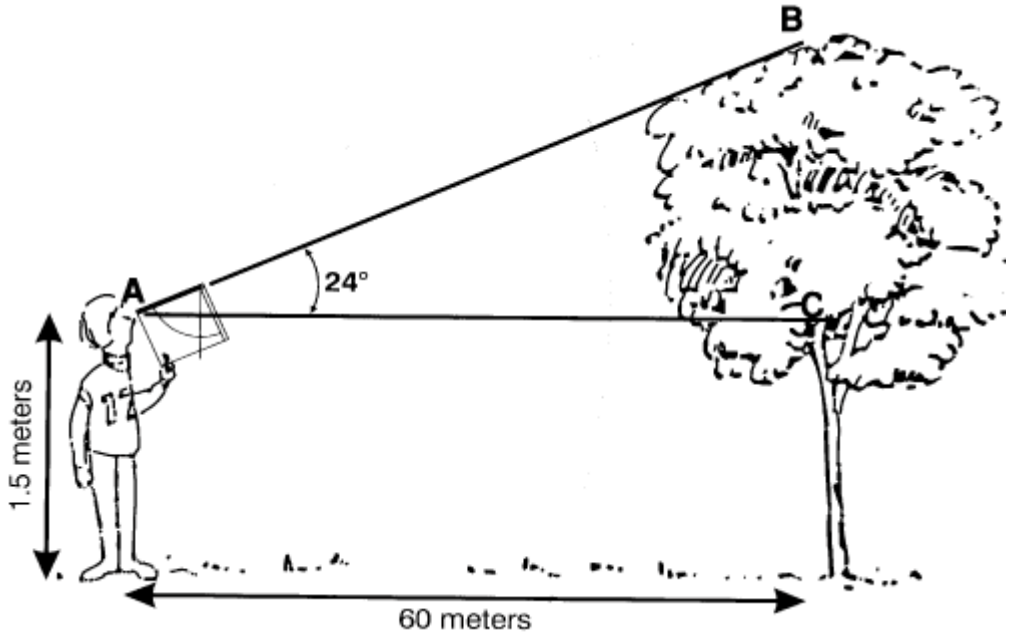
Figure LAND-P-14: Trigometric Equation



- Measure and record the height of your eye above the ground.
- Site the top of the tree through the drinking straw on the clinometer.
- Record the number of degrees in angle BVW on the clinometer; this tells you the number of degrees in angle BAC.

In the example (Figure LAND-P-15), a student stands 60m away from the base of a tree sites the top of the tree through his clinometer. His eye is 1.5 meters above ground. He reads an angle of 24 degrees on his clinometer (figures are not drawn to scale).

Figure LAND-P-15: Determining the Height of a Tree Using a Homemade Clinometer



Step 3: Organize Your Data in a Drawing

Refer to Figure LAND-P-14 to draw and label a triangle that represents all the information you have accumulated.

Step 4: Calculate Tree Height

- Use your Table of Tangents in the Appendix and the following equation to solve for the height of BC:

  TAN<A = BC/AC

  The above student solved his equation like this:

  TAN 24 = BC/60. Therefore,

  BC = 60 (TAN 24). Therefore,

  BC = 60(.45) = **27m.**

- Add the height of BC to the height of the clinometer from the ground (your eye level) to get the total height of the tree. In the above example, the height of the tree is 27m + 1.5m = **28.5m.**

Note: For younger students, if the angle BVW is 45 degrees, the distance from the tree will equal the height of the tree above the student's eye level and this can be illustrated for students by drawing an isosceles right triangle without any additional explanation of the mathematics involved.

Step 5: Repeat the Above Process for All Selected Trees

Step 6: Calculate and Record Average Tree Height(s)

- Add the heights (in meters) of the dominant species trees and divide by five to obtain their average height.
- If you have five co-dominant species trees, repeat the process for them.
- Record tree height averages on your Data Work Sheet.

Note: If you would like to practice measuring heights before going to your site, find a tall outdoor object for which you know or can directly measure the height (such as a flagpole or the school building). After completing the above process, compare your results with the known height of the object.

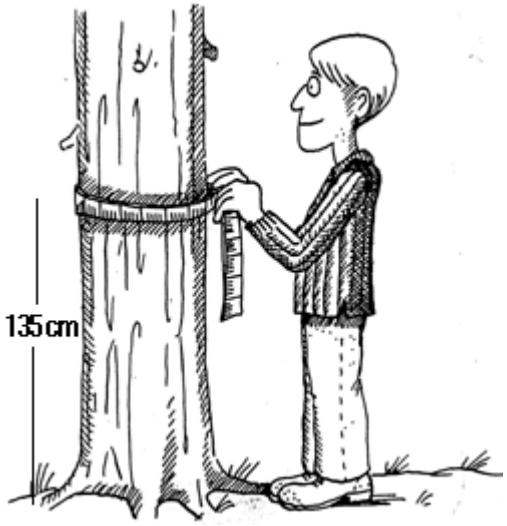
How To Measure Tree Circumference

Step 1: Measure and Record Tree Circumference

- With a flexible tape measure, measure the tree's circumference at exactly 1.35 m above ground level. Scientists call this measurement *circumference at breast height* (*CBH*).
- Repeat process for all five dominant species trees and, when applicable, all five co-dominant species trees.

- Record circumferences in centimeters on your Land Cover/Biology Investigation Field Data Work Sheet.

Figure LAND-P-16: Measuring Tree Circumference



Source: Jan Smolík, 1996, TEREZA, Association for Environmental Education, Czech Republic